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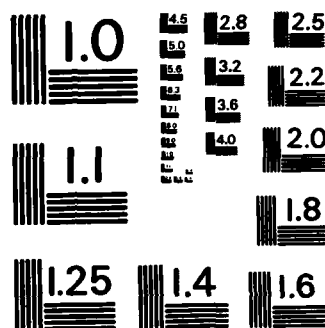
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FINAL REPORT

Contract Number DA79C0154

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October 1982

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DATA BASE DESIGN THEORY

"A Consulting System For Data Base Design"

The particular approach used to carry out the automation is the so-called "expert consulting system" in artificial intelligence. In an expert consulting system, the knowledge of the experts is expressed as production rules in an attempt to model the decision process of the experts. It provides human users with expert opinions about problems in specialized subject domains. However, it does not pretend to give final or ultimate conclusions to replace human decision making, i.e., it is intended only for "consulting" purposes. Examples of consulting systems developed are MYCIN, for bacterial infection diagnosis and therapy, and DENDRAL, for computing structural descriptions of complex organic chemicals from mass spectrograms and related data.

Several general programming systems have been developed for building consulting systems. Examples are EMYCIN. EMYCIN has the same basic framework as used in the MYCIN program. Knowledge is expressed as production rules defined in the EMYCIN program. Consulting systems for different applications can be created simply by the substitution of knowledge from different domains. Therefore, EMYCIN is accessible to users in many fields. AGE focuses on the development of common and basic consulting system components (e.g., rule interpreter, control mechanisms and explanation modules). These components can be immediately applied to different problems without being reprogrammed. Thus, AGE allows the user to experiment with different problem solving techniques without extensive reprogramming. AGE also provides an intelligent agent to guide the user in the application of these system components. In TERIRESIAS, the

interaction between the domain expert and the knowledge base in a consulting system is considered as an interactive transfer of expertise. Therefore, TEIRESIAN is designed to offer assistance in the interactive transfer of knowledge from a human expert to a consulting system. TEIRESIAS also includes an intelligent agent to offer explanation and debugging capabilities for building consulting systems.

This consulting system approach is of interest in areas such as logical data base (DB) design where there is no generally accepted design discipline and where no data base schema can be said to be better than any others in all circumstances. The purpose of a DB design consulting system is, therefore, to analyze a design problem and propose a feasible data base schema that solves that problem. The proposal is based on the system's stored knowledge about data base design. This knowledge, represented in production rule form, is collected from expert data base designers. A generated data base schema can be modified by the system's user. The system should be able to "learn" about data base design by accepting new production rules into its knowledge base, to the extent that they are not in conflict with the old rules.

In this paper, we formulate a report-drive data base design methodology in the framework of an expert consulting system. Central to an expert consulting system is an artificial intelligence (AI) production system, which is briefly discussed in section one. Section two introduces the notion of report schemata as the input of the DB design consulting system. Section three discusses three production systems: the first generates data item relations, the second finds the maximal member of a set of reports based on a concept called report covering, then the third generates a data

base schema. Extensions that address the issues of data integrity and interactive collection of semantic information are also discussed. Finally, to demonstrate that the above production systems are not necessarily a unique design procedure in a consulting system, we formalize another design method as a production system.

OFFICE AUTOMATION THEORY

"Internal Accounting Controls in the Office of the Future"

"An Introduction to the Theoretic and Analytic Capabilities of TICOM-II"

"The Theoretic and Analytic Capabilities of TICOM - II"

Although office-information-system prototypes and research articles tend to concentrate on the OIS's potential for enhancing worker productivity, the literature also expresses great concern that enriched job specifications and user decision-making accompany office automation. Both views are useful, interesting, and worthy of pursuit - as are many other perspectives on this topic. This article, however, concentrates on a matter not explicitly discussed in most of the OIS literature. In addition to enhancing productivity and providing worker support, OIS designs must meet organizational control constraints. In particular, they must meet a set of conditions concerning the adequacy of internal accounting controls. These conditions are the result of both good business practice and legal requirements.

DECISION SUPPORT SYSTEM THEORY

"A Generalized Decision Support System Using Predicate Calculus and Network Data Base Management"

In view of the growing prominence of corporate modeling, an important area of research concerns techniques for facilitating the design and utilization of models. In this paper we show how first-order predicate calculus can be used as a language for formally stating modeling knowledge. Furthermore, knowledge stated in this manner can be subjected to the resolution principle. The result is that application specific modeling knowledge need not be embedded in a computer program. Rather, it can be stored in a data base and utilized as needed by a problem processing system employing resolution techniques. Advantages of a decision support system taking an approach of this sort are considerable modeling flexibility, capacity for automating the model formulation and execution processes, and compatibility with a high-level user interface language.

"Future Directions for Developing Decision Support Systems"

A Formal, generic description of decision support systems is introduced. This description views a decision support system as having three principal components: a language system, a knowledge system, and a problem processing system. Several systems that fit the generic decision support system idea, but are (for the most part) not the customary kinds of systems encountered in business applications, are described. The concepts and techniques employed in these systems can make important contributions to the emergence of more powerful business-oriented decision support systems.

**"The Evolution From MIS to DSS: Extension of Data
Management to Model Management"**

In tracing the evolution of the decision support system (DSS) field from the management information system (MIS) field, several parallels in their early developments are evident. Early literature in the MIS area tended to be anecdotal and definitional. Similarly numerous DSS articles study basic questions confronting the DSS field, such as just what a decision support system is. Others discuss specific decision support systems that have been built for particular applications. In the 1960s many companies initiated MIS groups, making substantial commitments to create what they considered to be management information systems. Many of these companies deemed their investments to have been well-rewarded, in spite of the fact that debates about the definition of MIS continued. Similarly, an increasing number of companies are forming DSS groups, within and independent of MIS groups.

Over the years numerous generalized software tools appeared as aids for the development of application-specific management information systems. Generalized base management systems (GDBMS) for mainframes, minis and even micros are perhaps the most prominent of these tools. It is reasonable to expect that the next major innovation in the DSS field will be general software tools (beyond GDBMS) that facilitate the construction of application-specific decision support systems. The generic DSS framework is suggestive of the likely traits of this new class of software tools.

In addition, this framework also forms a basis for the comparative study of decision support systems. Following a brief examination of DSS characteristics and the generic framework, we introduce the notion of generalized problem processing systems (GPPS) as tools for building decision support systems. An application independent mechanism for handling application-specific knowledge is then proposed, focusing on the treatment of modeling knowledge.

"Specification of Modeling Knowledge in Decision Support Systems"

The DSS literature is plagued with muddled descriptions of implementations. Without a framework for comparison, discussion would be futile. This paper presents a theoretical framework for analyzing a DSS. A multilevel approach is employed to reflect the objectives and constraints of the many different DSS users. A design mechanism, based on data base management, is motivated by this framework.

PROBLEM SOLVING THEORY

"A Model Logic Framework for an A.I. Planning System"

A formal development of planning systems is constructed in this paper. The problem solving system is developed in the framework of a modal logic and the concept of weakest precondition is introduced to guide the solution procedure. The procedure is a generalization of several well known problem solving algorithms. Moreover, there may be some gains in practicality of the algorithm resulting from this extension, which is illustrated by an example.

"A Formal Model of Problem Solving"

A formal solution system for problems expressed in predicate calculus is proposed. A distance measure on the space of potential solutions is defined. It is shown how this can be used for monitoring progress toward a solution. Then it is demonstrated that two popular problem solvers have such a distance measure implicitly embedded in them. Finally, an example is provided showing that explicit application of the distance measure, called a pseudometric, may be useful.

LIST OF PUBLICATIONS

Data Base Design Theory

"A Consulting System for Data Base Design," C. Holsapple, S. Shen, and A. Winston, International Journal Information Systems, Vol. 7, No. 3, forthcoming, 1982.

Office Automation Theory

"Internal Accounting Controls in the Office of the Future," A. Bailey, Jr., J. Gerlach, R. McAfee, and A. Winston, Special Issue of Office Automation IEEE Computer Journal, May 1981.

"An Introduction to the Theoretic and Analytic Capabilities of TICOM-II," A. Bailey, Jr., J. Gerlach, R. McAfee, and A. Winston, Proceedings of the Second International Workshop of Office Information Systems, Couvent Royal de Saint-Maximin, France, 13-15 October 1981. [N. Naffah, editor, Project KAYAK INRIA, North-Holland Publishing Co., New York, 1982.] (Abridged version)

"The Theoretic and Analytic Capabilities of TICOM-II," A. Bailey, Jr., J. Gerlach, R. McAfee, and A. Winston, Proceedings of the Second International Workshop on Office Information Systems, Couvent Royal de Saint-Maximin, France, 13-15 October 1981. [N. Naffah, editor, Project KAYAK INRIA, North-Holland Publishing Co., New York, 1982.]

Decision Support System Theory

"A Generalized Decision Support System Using Predicate Calculus and Network Data Base Management," R. Bonczek, C. Holsapple, and A. Winston, Operations Research, March-April 1981.

"Future Directions for Developing Decision Support Systems," R. Bonczek, C. Holsapple, and A. Winston, Decision Science, Vol. 11, No. 4, October 1980.

"The Evolution From MIS to DSS: Extension of Data Management," R. Bonczek, C. Holsapple, and A. Winston, Decision Support Symposium Book, October 1982.

"Specification of Modeling Knowledge In Decision Support Systems," R. Bonczek, C. Holsapple, and A. Winston, Proceedings of the IFIP TC8 Working Conference on Processes and Tools for Decision Support, held in Vienna, Austria, 19-21 July, 1982. [H. G. Sol, editor, North-Holland Publishing Co., New York, 1982.]

Problem Solving Theory

"A Model Logic Framework for an A.I. Planning System," R. McAfee and A. Whinston, unpublished manuscript, 1980.

"A Formal Model of Problem Solving," R. McAfee and A. Whinston, International Journal of Policy Analysis and Information Systems, Vol. 4, No. 3, 1980.

PARTICIPATING SCIENTIFIC PERSONNEL

Professor Andrew B. Whinston
Professor Robert H. Bonczek
Professor Clyde W. Holsapple

ADVANCED DEGREES

Sheldon Shen, Ph.D.